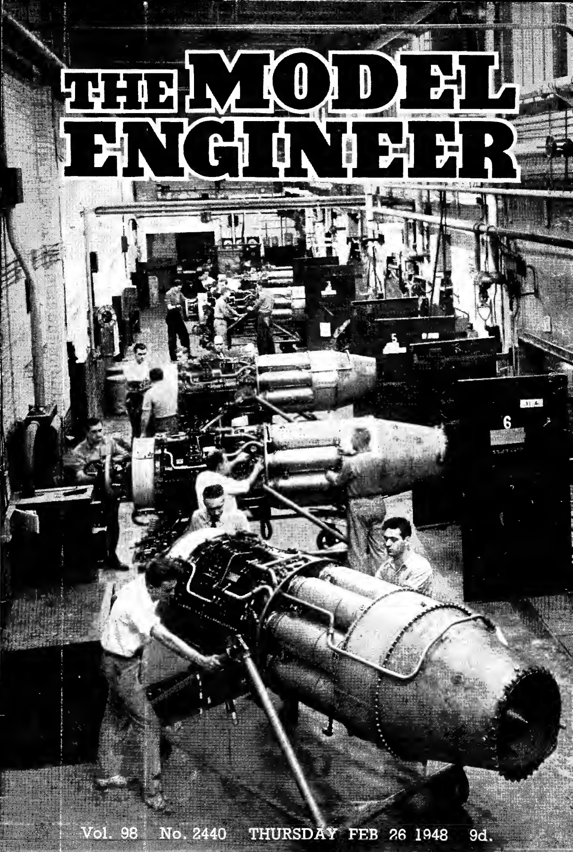
THE MODEL ENGINEER



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The MODEL ENGINEER

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SMOKE RINGS

Our Cover Picture

● THE GAS turbine engines seen in this picture are being prepared for test at The General Electric Company's factory in Massachusetts. A full power test is followed by dismantling, inspection and then a further final test before despatch. This engine is known as the T.G. 180 Axial-flow Gas Turbine, and besides being the present holder of the world's airspeed record, it is widely used in ten different types of jet-propelled military aircraft, ranging from single-seater fighters to a series of two, four, six and eight-engined bombers.

The Locomotive Outlook

● SOME INTERESTING comments on the future of the steam locomotive have been circulated to members of the West Riding Small Locomotive Society by that energetic enthusiast Mr. Dan Hollings. He writes :—"Fortunately a long time is bound to elapse before the effects of the grouping into four main groups in 1923 are eclipsed, indeed after the 25 years, 1923-1948, there are still very many locomotives giving good service, and other rolling stock too, which belonged to the old constituent companies forming the four main groups. The prophets have already been busy with forecasts of the early demise of the steam locomotive. The advent of the new No. 10,000 L.M.S. Diesel Unit has excited much comment and there is little doubt but that this type of unit has the largest type of express locomotive well beaten for certain special types of running. This has already happened in the U.S.A. The 'Diesel Unit' needs oil fuel, and in the States this fuel is indigenous ; here it is not, and that's just the reason why the 'Diesel' cannot be allowed to push the steam locomotive off the rails in the same way as the internal combustion engine has virtually swept the steam locomotive from our highways. The chances are, I think, that steam will hold its own on the railways and stage a 'comeback' on the highways too. So I think we small locomotive 'fans' can take comfort in our championship of the steam engine in this country. Our Government cannot allow the strategic position to depend on imported oil. It is certain, however, that in time, policies of standardisation will reduce the types of locomotive in use to a convenient low figure and while this will sap some of the interest in current types, we have the consolation that there is a mine of inexhaustible interest in making research into types of engine used in the past. Builders of small locomotives are doing something very useful when they reproduce, in miniature, types of locomotive long since forgotten. The more obscure or remote the prototype was, the more interest it creates today. The practice of bringing to life old types should be encouraged.

When 'standardised' types of locomotive have infiltrated into all parts of 'British Railways,' here we may have the antidote to the otherwise deadly dullness too much standardisation may bring. Those who are old enough to remember the life, the colour, the individuality of the rolling stock, the personnel and all that went with the old pre-1923 companies—not to mention the 'efficiency' which could give a 'Day Trip' Newcastle to London and back for 3s.—has gone for good, can be excused for being a bit sceptical that 'Nationalisation' could ever hope to beat the feats of 'those were the days.'" I am sure that Mr. Hollings' words of wisdom will be echoed in the hearts of many "M.E." readers. Hands up for "live steam"!

A Friendly Trade Gesture

● ONE OF my South African readers, after referring to the friendliness of model engineers in general quotes a pleasing example of trade courtesy. He writes :—"This spirit of friendliness is also found in the advertisers in 'our paper,' as the following experience I have had with one of them just recently shows. I returned an automatic centre punch, which I had in use many years, and needed adjustment, to the makers, James Neill, the 'Eclipse' people. They have just written me air mail, saying that although the punch was only slightly out of order, they were sending me one of the latest designs, in place of it, which they hope I will accept free of charge. I think it is very nice of them indeed."

A Society for East Lothian

● NEWS REACHES me of the formation of a new Society for the East Lothian area. Mr. George B. Ritchie writes :—"We have held meetings and have elected Office-Bearers. At the subsequent committee meeting funds were got under way and premises were secured. A very good membership is expected and the project seems likely to be successful in the district. We are in close co-operation with the Edinburgh Society who have expressed their pleasure on hearing of the founding of our Society." Full information as to meetings may be obtained from Mr. Ritchie at 9, Hardgate, Haddington, East Lothian.

Spring Comes to Vancouver

● MR. WELLWOOD R. JOHNSON, the Hon. Secretary sends me what he calls a "sulphur and mollasses" treatment which he is issuing to his members, in view of the coming of Spring. I quote the following :—"We plan to take a really outstanding part in the Hobby Show this year. We were told that our corner at this show attracted a great number of patrons last year. We want to do better this year, so come along and help, even if you do not have a home workshop yet. We hope to have more work of an elementary nature this year from the less experienced members, so how about commencing with a simple boiler or a little locomotive similar to the one described in a recent issue of THE MODEL ENGINEER? You do not require a lathe or expensive tools for this. In the last few weeks one of our members has developed a small and simple tool to make bolts for model work. The club-owned set of patterns for the horizontal steam mill engine is working overtime. Several sets of castings are under construction and several engines have been finished. Work is being planned for the improvement of the club track at Brighouse. In spite of the bad weather some enthusiasts have been out with their engines recently." Mr. Johnson's address is :—3340, West First Avenue, B.A. 6159L, Vancouver.

Models for Inventors

● THE SECRETARY of the Institute of Patentees writes :—"Early in 1946 you kindly gave notice to the fact that the Institute wished to compile a list of model makers. A very satisfactory response was received and the list has been useful to members. However, as a number of these model makers are not now functioning it is desirable that the list be brought up to date. It is appreciated that the first class model is an expensive matter and not within the means of all inventors, so that not only are professional model makers required but also those who can improvise and produce a model which demonstrates an idea or principle. The Institute would be pleased to hear from such persons or firms willing to undertake such work and would appreciate some indication of the class of model their equipment enables them to cope with." Replies should be addressed to the Institute at 207-208, Abbey House, Victoria Street, London, S.W.1.

An Invitation from Toronto

● I AM pleased to pass on a very cordial invitation from the Toronto Society to model engineers who may be visiting that part of Canada, to attend their meetings. The Society meets every three weeks, on Fridays, at 8 p.m. in Room 8 of the Botany Building at the University of Toronto. Future meetings are fixed for March 12th, and April 2nd and 23rd. The Hon. Sec. is Mr. W. F. Choat, 38, Greenview Boulevard, Toronto. This invitation reaches me through Mr. L. G. Bateman who paid us a visit in London last summer. He says the society now has over 100 members, an outdoor track laid in $2\frac{1}{2}$-in. and $3\frac{1}{2}$-in. gauges, and a boat pond. The Toronto Parks Board have been most co-operative in arranging a site for the track and the pond, and have done quite a lot of work in enlarging the pond, levelling the ground for the track, and keeping the surrounding grass in order. Mr. Bateman rejoices in a new home, to the building of which he has contributed quite a lot of personal work, including the electric wiring. He says "With a new home, of course the workshop was very well looked after." Now that he is settled in he is carrying on with the building of his "Trevithick" model.

Percival Marshall

The MODEL ENGINEER 1947 Speed-Boat Competition

DURING the long history of this competition, which, it may be observed, is almost as old as THE MODEL ENGINEER itself, a noble cavalcade of famous boats and personalities has been brought before readers, and the march of progress, not only in the attainment of speed, but also in the design of hulls and engines, has been recorded yearly, with the exception of two gaps caused by world wars. It is a matter for regret, but not for surprise, that the recovery of model speed-boat activity since the last war has been depressingly slow. Few types of models make more exacting demands, both in respect of material, and the skill, patience and resources of the constructor, than model speed-boats. Although actual construction may be accomplished fairly quickly, they call for long preliminary planning and experiment beforehand, and further experiment, trial and tuning afterwards, before the fruits of full success can be tasted.

Mr. Lines's "Blitz II" under way

It is, therefore, no mere chance, nor is it any discredit to the industry and enterprise of the model power-boat fraternity, that the two years since the war have not been vintage years in the story of speed-boat development. Many new boats are being built, and new ideas being tried out, the ultimate results of which may not be seen for some time yet, but will surely appear in their due course. The conclusion of certain critics that model speed-boats have "had their day" is not only premature, but shows either an ignorance or a lack of appreciation of the problems and difficulties with which their constructors are faced, especially in these days of restricted supplies and facilities.

An incidental set-back which many clubs and individual experimenters have had to contend with since the war is the lack of suitable ponds for the running of speed-boats. Several clubs report that their ponds are fouled with weeds, or have become a dumping-ground for junk, while in some cases, Army and N.F.S. exercises have temporarily or permanently ruined what were once highly suitable stretches of water. It is too much to hope that these matters can be put right in the near future; but an even greater deterrent to model power-boat activity, which has always been with us, is the unhelpful attitude of local authorities in respect of granting facilities for the use of ponds in public parks.

It is rather interesting to note that since the war there has been a distinct revival of interest in flash-steam driven boats. This form of motive power, which was the first to make really sensational progress in the attainment of speed, had declined in popularity almost to the point of extinction a few years before the war, but now appears to have gained a new lease of life, while the internal combustion engine, in spite of its rapidly increasing popularity in other types of models, shows a marked drop in virility in model speed-boats.

This development may appear somewhat bewildering, but it is possibly capable of a logical explanation. During the war, facilities for development of highly-tuned petrol engines were very much curtailed, and since the war, supplies of essential materials and accessories for these engines, such as ignition equipment, batteries, and special fuels, have been restricted. In such cases, reversion to the somewhat more obvious possibilities of the steam engine has naturally followed. The flash-steam plant is in many respects ideally suited to installation in a boat, facilitating weight distribution, low centre of gravity, and unrestricted power development; and its more exacting demands in respect of maintenance and adjustment are but little deterrent to the enthusiast. But be that as it may, it is a fact that the 1947 season has been notable mainly for the success of flash-steam boats in nearly all important regatta events.

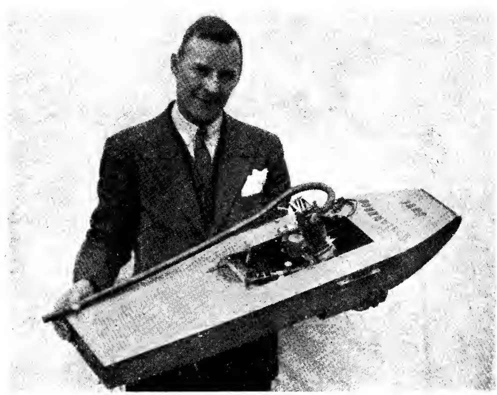
Hull Design

In the boats represented in the 1947 competition, there is very little sign of any revolutionary tendencies in the design of hulls, though this is a subject on which there is at present much discussion, and a fair amount of experiment, in model power-boat circles. Much has been said about the progress of hull design in other countries, but while this is being very closely watched, British constructors are running true to form in their cautious and conservative outlook. To those who regard this as unprogressive, it may be observed that the individualist always gets farther in the long run than the mere copyist, and there is still much to be learned about the design of orthodox and well-tried types of hulls. In any

case, most of the boats have hulls which were built, or at any rate designed and developed, several years ago.

The severely simple "scow" type hull is still with us, but of late years there has been a tendency to modify it for definite and specific ends, such as by tapering the hull from front to rear to improve the buoyancy and lift at the forward end, or to introduce curves, with the object either of partial streamlining, or improving structural rigidity, which is probably the more important from the practical point of view. All hulls are of the single-step type, and planing angles appear to be moderate, though exact details in this respect are not available, and the same applies to the use of "false" or adjustable planing surfaces. None of the hulls in the competition appear to have narrow planes of the type variously referred to as "pontoons," "sponsons" and "outrigger planes," though it is known that a good deal of experiment is being made with these devices at present.

In all THE MODEL ENGINEER Speed-boat Competitions, particular interest has centred around engine design, which gives considerable scope for individual ingenuity and research. It is one of the conditions of the competition that both the hull and the engine must be built by the constructor, though the use of castings and parts to a set design, also finished components within reason, are allowed. In practice, it usually happens that the designs, or at least many of the important details, of the engines are original, and particular ingenuity is shown in this respect in the flash-steam plants, in which there has never been any rigid orthodoxy, and for which no castings and parts are available. The time-honoured practice in building these engines is to fabricate the parts or machine



Mr. K. Williams with "Faro"

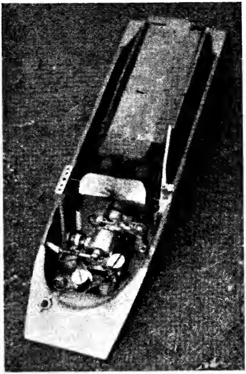
them from the solid; and this appears to be adhered to in the examples seen in the present competition.

All the engines in this class are of the single-cylinder single-acting type, that of Mr. Lines's *Blitz II* being fitted with poppet inlet and exhaust valves, the former having means of retarding the timing to assist starting. The bore and stroke of the engine are $1\frac{1}{8}$ in. by 1 in., respectively. Twin oil pumps, geared down 100-to-1 from the engine, supply oil to the valve chest, and to separate feed pipes on the engine, transmission and propeller shaft bearings. The boiler of this boat consists of 10 ft. of $\frac{5}{16}$ in. diameter, and 30 ft. of $\frac{1}{4}$ in. diameter steel tube (40 ft. in all), and is fired by a single torch-type blowlamp, having an unusually large burner with a flame tube $3\frac{1}{2}$ in. diameter by 6 in. long, and six jet nipples. It works on an air pressure of 25 lb. per sq. in., and the fuel reservoir is of tinplate 0.008 in. thick, reinforced with a winding of

piano wire, and domed copper end-plates.

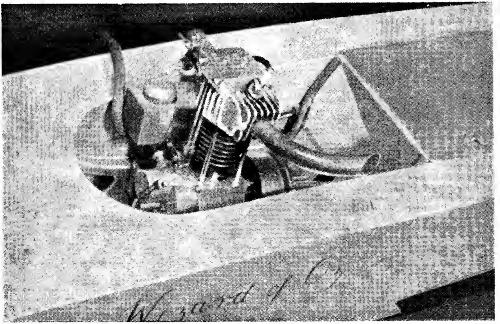
Mr. Pilliner's *Ginger* has an enclosed engine, 1 in. bore by 1 in. stroke, having a single piston valve, operated by an eccentric, driven from the crankshaft by an ingenious quick return motion, which improves the timing of the steam distribution. The boiler consists of 59 ft. of ¼-in. diameter steel tube, which starts as a single coil and splits up into two parallel coils. It is fired by a torch-type blowlamp, having four jets, and fed positively by means of an engine-driven fuel pump, which produces a constant pressure of about 40 lb. per sq. in. at the jets.

The engine of Mr. F. Jutton's *Vesta* is ⅞ in. bore by 1 in. stroke, and the boiler consists of 24 ft. of ¼-in. diameter steel tubing, fired by twin blowlamps, having a single jet in each, and flame tubes 4½ in. long by 1½ in. diameter. It is fed under air pressure in the orthodox way, by pumping up the container to a pressure of 40 lb. per sq. in.



Mr. Jutton's B class flash steamer "Vesta"

Of the petrol engines in this competition, only one is a newcomer to THE MODEL ENGINEER competition, both Mr. Williams's *Faro* and Mr. Innes's *Satellite III*, having had a distinguished pre-war career. The performance of *Faro* is far below her best recorded speed, and as long ago as 1937 this boat attained 41.15 m.p.h. in THE MODEL ENGINEER speed-boat competition. Much the same applies to *Satellite III*, which attained 38.26 m.p.h. in the 1939 competition. Both these boats, therefore, are entitled to be regarded as veterans, and their longevity in such arduous duty is a testimony to the stamina



The o.h.v. four-stroke engine of Mr. Weaver's "Wizard of Oz"

and sound design of their engines. *Satellite's* engine is now fitted with magneto ignition.

Mr. Weaver's *Wizard of Oz* was built during the war, and the engine is one of the neatest and daintiest yet seen in a model power boat. It has a bore of 29/32 in. and a stroke of 15/16 in., and is fitted with inclined valves, having an included angle of 60 degrees, and a built-up crankshaft with internal flywheels. The carburettor is of the "mousetrap" (hinged-flap throttle) type, and lubrication is by crankcase pressure, using disc non-return valves.

It is interesting to note that the predominant popularity of the four-stroke engine, which has always been a feature of boats built in this country, is still maintained; despite the intensive development of the two-stroke engine in recent years, not a single representative of this type has appeared in the 1947 competition.

Propellers and Transmission Gear

All the engines have direct drive to the propeller shaft, through the usual couplings and universal joints, and single propellers are used on all boats. The two-bladed type of propeller is universal, being the most convenient to construct and set, and probably at least as efficient as any other type in practice. So far as can be gathered, the articulated propeller shaft, giving a low thrust line to assist lifting the front of the boat, is universally employed. Both the blade area and the pitch of propellers is greater for the flash-steam boats than those driven by I.C. engines, which is usual in view of the higher torque obtainable in the former type at low and moderate r.p.m., preventing the tendency to "stall" which is very prevalent in petrol-driven boats.

Personal Notes

Apart from Mr. Williams and Mr. Innes, whose names are familiar to readers who have followed pre-war competitions and regatta reports, the other contestants are comparative newcomers, though by no means raw beginners, Mr. Pilliner and Mr. Jutton have long been active members of the Guildford club, though the former has now removed to the vicinity of Southampton (which, by the way, seems to be a salubrious climate for breeding flash-steam boats, to judge by the past successes of local enthusiasts, though they are unfortunately unrepresented in the present competition). Most of Messrs. Pilliner and Jutton's experimental work was carried on during the war, the Guildford club being in a fortunate position in having an excellent pond which, it seems, was never closed down or commandeered.

Mr. Lines is one of the most progressive members of the Orpington club, who has evidently given very serious study to the design of flash-steam plant, besides putting in some very sound practical work. His early experiments with flash-steam boats produced not only the normal mechanical teething troubles, but also some terrifying (though harmless) fires and explosions, which may possibly have influenced the naming of his boat.

The sole representative of one of the oldest clubs in the country—the Victoria Model Steamboat Club, which has produced some of the most famous speed-boats—Mr. Weaver has put in several years of quiet and unobtrusive, but very thorough work in the development of small petrol engines, and has used them not only in boats, but also in model racing cars. His workmanship is of an extremely high standard, and his engines not only work well, but are a real joy to behold.

We conclude by expressing the hope that the efforts of these few stalwarts who have supported the 1947 competition will inspire many others to follow in their footsteps, and ensure a really large and representative entry in the 1948 competition.

Naval Development of the Gas Turbine

THE Royal Navy, having taken the lead in a new phase of marine propulsion by being first afloat with a craft powered by a gas turbine, is now pushing ahead with the development of this class of machinery.

Admiralty and industrial experts are, today, examining the Gatric unit, installed in M.G.B. 2009, which has completed 55 hours' running during sea trials in the Solent. In the course of these trials some 3,000 tons of salt air has been pumped into the red-hot combustion chamber.

It was expected that salt deposits would foul the blades of the compressor which forces the air into the combustion chamber, and that there would have been a considerable lowering of the power output. In fact, the power loss was less than was expected and, when the engine was opened up at the Manchester works of Messrs. Metropolitan-Vickers, there was less salt than had been anticipated. The good general condition of the engine augurs well for the future of the gas turbine as a marine propulsion unit.

M.G.B. 2009 is to be fitted with a new slightly modified Gatric unit, which will soon start sea trials on the Solent. This unit will be run continuously for many hundreds of hours to ascertain its total useful life at sea.

The Admiralty is, also, planning larger gas turbine machinery for installation in a vessel of the escort type. In this project the machinery has been designed for marine purposes from the initial stage and it is predicted that its durability and efficiency will be greater than those of the Gatric units.

Another project is the powering with gas turbine machinery of H.M.S. *Grey Goose*, a gunboat of 250 tons, considerably larger than M.G.B. 2009. Powered by compact and lightweight steam turbine machinery, she was the leader of a flotilla which acquired a reputation during the late war as "E Boat Killers."

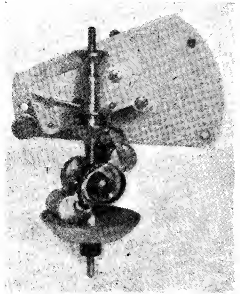
*Swords into Ploughshares

Hints on the adaptation of "surplus" war material for model engineering or utility purposes

Notes on Aircraft Instruments

by "Artificer"

SEVERAL different types of instruments are employed for the measurement of rotational speed of engines and auxiliary machinery. While these are functionally identical with the "speedometer" with which all motorists are familiar, the instruments used on aircraft are not only of extremely high quality, but they operate on several different principles, and



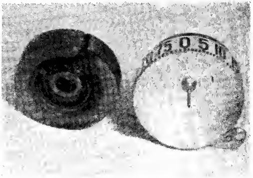
Mechanism of centrifugal type speed indicator

include both mechanical and electrical types. Some means of indicating speed is extremely useful in every engineering workshop, and as a good instrument specially designed for test bench use (generally known as a "tachometer") is very expensive at the present day, the possibility of adapting a "surplus" aircraft instrument to serve this purpose will undoubtedly appeal to many readers. In some cases these instruments need little or no alteration, beyond the addition of one or two simple fittings; in others they may call for recalibration, or more or less extensive modification; while some instruments would call for such drastic alterations that their adaptation could hardly be considered worth while.

Continued from page 165, "M.E.," February 12, 1948.

Mechanical Speed Indicators

These instruments are in nearly all cases coupled to some conveniently located shaft on the engine or auxiliary gearbox by means of a flexible shaft, in essentially the same way as a motor-car speedometer. There are three established types of these instruments, namely, the magnetic, centrifugal and chronometric types, and, gener-



Rotary magnet and drag cup of magnetic speed indicator

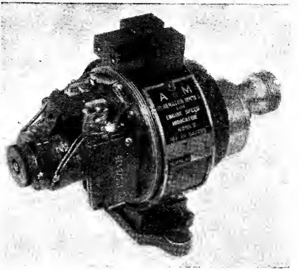
ally speaking, their complexity and accuracy may be placed in the reverse order to that set down here.

The magnetic speed indicator might possibly be regarded, by those who have a passion for strict accuracy, as an electrical type of instrument, since its action depends upon electro-magnetic laws; but it has no wiring or other obvious electric apparatus in it, and it is usually placed in the mechanical category. It is the simplest of all these instruments in construction, the mechanical moving part being simply a permanent magnet, and the indicating mechanism nothing more than a metal disc or cup on a jewelled or finely pivoted shaft, with a hair-spring and pointer.

The action of this device is as follows: the disc or cup is located concentrically within the field of the rotary magnet, and as close to it as possible, so that it behaves in exactly the same way as any other conductor in a magnetic field. That is to say, rotation of the magnet induces electric currents in the disc, as in a dynamo armature, but in this case they are simply short-circuited in the disc, and not led away to an external circuit. If the currents were of any great magnitude, this would result in heating the disc, but in practice they are very small, and result only in the disc being pulled around in

the same direction as the magnet, the amount of torque exerted being dependent upon the speed at which the latter is moving; and thus the extent of the movement of the disc against the reverse pull of the hairspring, recorded by a pointer on the disc shaft, can be calibrated in terms of rotor-shaft speed.

It should be clearly understood that the disc or cup is not in itself magnetic, being of non-ferrous metal, so that it is not attracted by the magnet when stationary. If this were so, the static torque would be high and in no sense proportional to rotor speed. It is essential that the torque should depend on the rate at which the rotor moves, and should be entirely absent at zero speed.



D.C. generator for the Air Ministry Mark II engine speed indicator

in which they are used can be relied upon to attain and maintain a very tolerable degree of accuracy, though not perhaps equal to the best examples of other mechanical types. One advantage of the magnetic instrument is its extremely light action; it takes very little power to drive, and may be applied to low-power machines without imposing a load liable to slow them down, and thus show a false reading.

The centrifugal type of indicator works on the well-known principle of the centrifugal governor, and in at least one form of this instrument, pivoted weights arranged in a comparable manner to that of an engine governor are applied. But in most cases, a much simpler mechanical device is used; namely, a massive ring pivoted across its diametric centre, and mounted

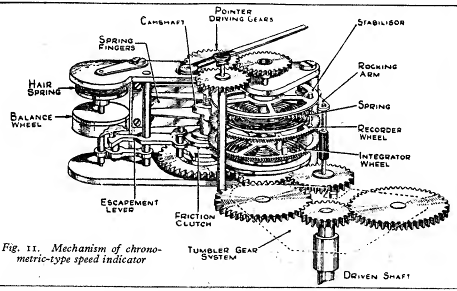


Fig. 11. Mechanism of chronometric-type speed indicator

Magnetic instruments are not very extensively used in modern aircraft practice, as they have certain disadvantages, and in the past, have often acquired a bad name, mostly on account of the instability of the magnet steels used, which were liable to become demagnetised under the effects of shock or vibration. Modern magnet steels are much better in this respect, and instruments

on the shaft of the instrument so that it is free to tilt. Under static conditions, it lies at a considerable angle to the true cross-plane, under the influence of a torsion spring, but when rotating, centrifugal force on the ring tends to pull it into a position normal to the shaft, the strength of pull being dependent on the rate of revolution. By means of a link attached to one side of the ring, this

movement is transmitted to a grooved collar on the shaft, moving the latter endwise, and a fork engaging in the groove, operating through rack and pinion gear, actuates the pointer of the instrument.

Chronometric or "isochronous" speed indicators vary considerably in detail, but in all cases they embody some form of positive time-measuring device, which is usually similar in essential respects to the escapement of a watch, and works at a constant rate all the time the instrument is working, the power usually being taken from the driving shaft through a slipping clutch, which applies a constant torque. Some types of instruments, however, have embodied a separate and complete clock movement, driven by a spring or electrical means. The function of the time mechanism is to control a system of clutches by means of which the pointer shaft of the machine is intermittently driven positively from the driving shaft of the indicator through reduction gearing. At the end of a definite period of time, the clutch is released and the pointer shaft drops back to zero, the process being repeated each time the clutch is operated. Instruments of this type are sometimes equipped with a second "stabilising" pointer, which remains in the position last reached by the integrating pointer, enabling a reading to be taken at any time; but it is common practice to have only the stabilising pointer visible on the dial, so that the observer is not confused by the intermittent movement of the integrating pointer.

It will be clear that if the pointer shaft is mechanically geared to the driving shaft for a definite length of time, the angle through which it moves will be directly proportional to the speed. This is the very elementary principle on which this instrument operates, but its practical interpretation involves the use of very delicate and complex mechanism, which is often regarded as a "bag of tricks," but is no mystery to anyone who understands its basic principles.

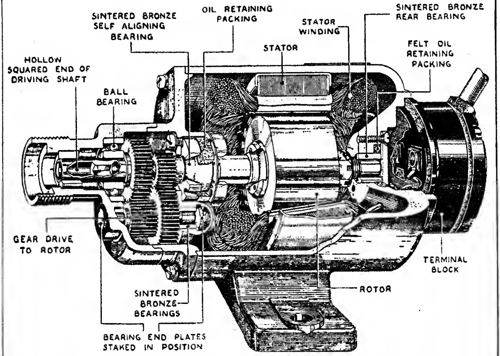


Fig. 12 Three-phase a.c. generator for remote reading engine speed indicator

In the instrument illustrated in Fig. 11, provision is made in the driving gear to ensure that no matter which direction the driving shaft moves, the instrument is always driven in the right direction. This is done by means of a system of tumbler gears, mounted on a rocking lever in such a way that they are shifted bodily round in the direction of the shaft rotation by frictional drag, and thus engage the instrument through one or other of two constant-meshed gears to produce movement in the right direction.

The escapement, seen to the left of the drawing, is of the lever type, with balance-wheel and hairspring, and is actuated from an escape-wheel on a shaft driven through a friction-clutch from a gear-wheel meshing with one of the same size on the main shaft. The escape-wheel shaft is equipped with cams which periodically engage the toothed rocking-wheel with the integrator wheel, so that the movement of the latter is communicated to the recorder wheel,

and in turn to the stabiliser, to which is attached the pointer (in this case the only one on the dial). The integrator and recorder wheels are fitted with return hairsprings, and fall back to zero when disengaged, but the stabiliser remains in position until reset on the next cycle of the instrument.

It will be seen that the action of this type of indicator does not depend upon the adjustment of return springs or the strength of a magnet, and can thus be relied upon to maintain an accuracy equal to that of a good clock. For this reason it is always used for purposes in which a high degree of accuracy and reliability are most essential.

In the conversion of any of these instruments to use in the workshop or on the test bench, it should first of all be noted that the speed indicated on the dial does not necessarily represent the actual speed of the driving shaft, as they are often driven through reduction gearing at half, quarter or possibly some odd ratio to the engine speed. The ratio is usually, but not always, indicated on the back of the instrument case, thus, the figures 2 : 1 denote that the instrument is designed to run at half engine speed, or in other words, that the speed shown on the dial represents twice that of the driving shaft. If, however, the speed ratio is unknown, it may be checked by running the instrument from a machine, the speed of which is approximately known, or which can be measured by a counter and stop-watch. Re-calibration, to run on a different ratio of speed to that for which the instrument was designed, is just a matter of simple arithmetic.

For permanent application of an instrument to a particular machine, the original flexible drive may be used, or it may be convenient to mount the instrument so that it may be aligned with the driving shaft and direct-coupled. Gear-drive is also practicable, but a suitable bearing should be fitted to the driving-shaft socket to withstand side thrust ; the same applies to belt drive, which is, however, only suitable for very rough speed measurement.

For use as a hand tachometer, it is necessary to fit an outer bearing for an extended shaft, which should be equipped with means to take friction tips of various types, with metal or rubber contact surfaces, according to the purpose for which they are to be used. A valuable refinement is the addition of a gearbox to enable two or three ratios of speed to be obtained ; as a simple expedient a 10-1 worm-gear may be provided to fit over the existing shaft end, and with the worm shaft adapted to take the same tips as the direct shaft. This enables speeds up to 10 times the normal range of the instrument to be measured. Peripheral speed can be measured by fitting the instrument with a friction disc of a known circumference—preferably some definite fraction of a foot, to simplify calculation.

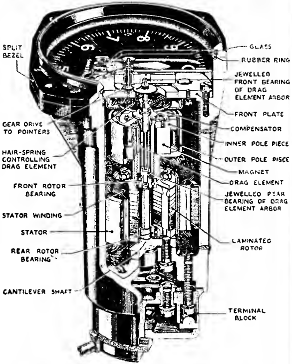


Fig. 13. *Indicating unit, including three-phase a.c. motor and magnetic speed indicator*

Electrical Speed Indicators

These instruments embody two distinct units—a generator and an indicating instrument, the former of which may be mounted directly on the engine, or coupled up to it by a flexible drive shaft, and it is connected to the indicating instrument by wiring. The main advantage of this type of instrument is that it may be placed in any position or at any distance from the engine, without involving complications in the drive or transmission arrangements.

The simplest form of electrical speed indicator is an elementary type of dynamo or magneto, connected up to a simple electrical measuring instrument such as a voltmeter or ammeter, having suitable calibration and characteristics to enable the full range of voltage or current output of the machine, at all speeds, to be measured. The generator may produce either direct or alternating current, the former being most readily measured to a high degree of accuracy by a moving-coil type of instrument, but it suffers from the disadvantage of having a commutator with brushes, the contact resistance

of which may vary and thus produce inaccurate readings. Alternating-current generators, on the other hand, need have no rubbing contacts, but they call for the use of a moving-iron type of measuring instrument which has a lower inherent accuracy, and hysteresis losses may also influence the reading. Instruments of this type are, however, sometimes equipped with a metal rectifier, to enable a moving-coil meter to be used. It is usual to measure the voltage output of the machine, rather than the current, as it is more truly proportional to speed, and it enables smaller conducting cables to be used between the generator and the indicator.

Both D.C. and A.C. generators have been used in practice, a typical example of the former being the Air Ministry Mark II type, which is a permanent-magnet machine having an eight-section drum armature and copper gauze brushes. It is driven through double-multiplying gearing, either direct-coupled or by way of a flexible shaft. The indicator for this machine is a large-scale quadrant moving-coil voltmeter, with suitable calibration.

The form of instrument now most commonly employed consists of a three-phase A.C. generator, connected to an indicating instrument which embodies a synchronous motor and a magnetic-type tachometer. (Fig. 12). Both the generator and the motor have two-pole rotors, the former being in the form of an "Alnico" magnet mounted on a shaft which runs in self-lubricating bronze bushes. The stator is built up of slotted laminations and carries a star-connected three-phase winding. A similar stator and winding is employed in the indicator, which is connected to the generator by three wires; the rotor is laminated and resembles that of an induction or "squirrel-cage" motor, but contains a permanent magnet to lock the rotor in true synchronism with the generator. (Fig. 13.)

A specially compensated form of magnetic tachometer is employed, having a cup-shaped copper-alloy drag ring, the arbor of which runs in jewelled bearings, the inner one of which is mounted in the end of the rotor shaft. It is geared to the pointer shaft, and the gear ratios may be varied to suit the calibration of the instrument.

Electrical speed indicators can, of course, be adapted to measuring the speed of any rotating machinery within their range, in the same way as the mechanical type, and have the advantage over the latter in that the indicator dial may be located at a distance from the generator. The simple D.C. or A.C. types of generators may be employed to produce current for lighting or experimental purposes, but the three-phase generators would be less useful in this respect, though it is possible to split up the phases and obtain single-phase current between one phase wire and the neutral point, as is done in the supply mains. The cycle frequency, and to some extent the voltage, will depend on the running speed; with a two-pole rotor, a speed of 3,000 r.p.m. will produce 50 cycles per sec. For some kinds of experimental work, it is extremely useful to have some means of obtaining exact synchronism between two shafts (as, for instance, in stroboscope or oscillograph tests on high-speed mechanism), which is easily obtained from this type of instrument. The "Alnico" magnets of the generators would be extremely useful to constructors of miniature magnetos and other electrical apparatus.

The types of aircraft instruments described in this series of articles do not by any means exhaust the full range of those used in modern aircraft; but they are by far the most common, and probably most likely to be encountered by the experimenter. If information is required on other types of instruments which may become generally available, it will be forthcoming; but it should be noted that these articles are not intended as a general abstract treatise, and there is no point in giving a detailed description of things which may never be seen by the average reader. The primary object of pointing out and giving advice on how the instruments may be put to useful service, will, it is hoped, be recognised and appreciated by such readers.

(To be continued)

For the Bookshelf

Daimler—1896 to 1946, by St. John Nixon. (London: Foulis & Co. Ltd.) Price £2 2s. od.

This beautifully produced and well illustrated work on the history and achievements of the Daimler Motor Co. Ltd. is of immense interest to students of motor-car design, for this famous British concern was formed before the "horseless carriage" was legally allowed to run on our roads. To follow Daimler design and construction from that time down to the present day, through two major wars, as fascinatingly told by Mr. St. John Nixon, who is secretary of the Veteran Car Club, cannot fail to be instructive. It is also a very good stimulant for flagging morale, for some of the finest cars ever produced and some of the most effective fighting vehicles emanated from the Coventry factories of Daimler Limited.

One of the most interesting things about "Daimler—1896 to 1946" is the detail devoted to Daimler cars supplied from the very earliest days to the Royal family. The original financial struggles of this now great concern, which very early in its career was honoured with orders for motors for the use of His Majesty, are told in detail and many historic letters and documents of great interest are reproduced. Many of the photographs are of considerable historic value and it is pleasing to find that several of the old cars illustrated are still in good running order to this day and, indeed, took part in Veteran Car Club events immediately prior to the ban on pleasure motoring now operating in this country. Such cars offer a fascinating subject for the model maker.

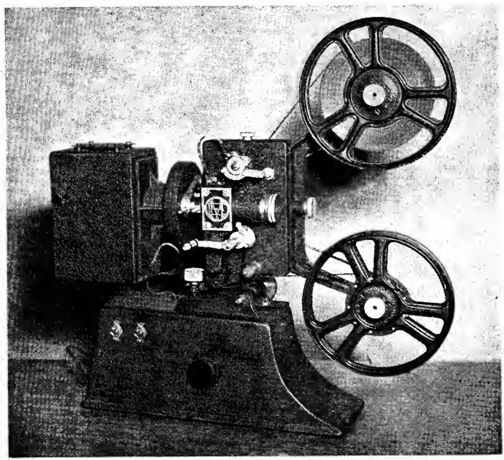
The book is indexed and concludes with a full list of all the production Daimler cars, with details of their mechanical features, from the 4½-h.p. two-cylinder of 1897 to the 5½-litre straight-eight of 1946.—W.B.

A Joint Exhibition

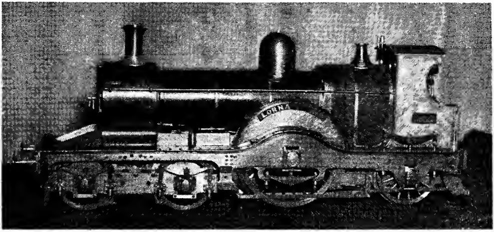
LUTON'S second joint model engineering exhibition organised by Vauxhall Motors Recreation Club, Model Engineering Section, was held during the week December 8th-13th, 1947, in the Winter Assembly Hall at Luton. The attendance was some 6,000 people, and the general opinion was that the standard of workmanship displayed by the nine societies taking part was very high indeed.

A feature that always draws a large crowd, both young and old, is a miniature passenger-hauling railway, and the inclusion of this feature added much to the complete success of this venture. Acknowledgment is therefore due to Mr. D. H. Bond, Mr. Fred Lane, Mr. Dick Eborn and their co-drivers who between them hauled some thousands of children during the week. Mr. Bond ran his $3\frac{1}{2}$-in. gauge L.M.S. 4-6-0 Mixed Traffic engine, a magnificent example of true-scale modelling with a purpose. Mr. Lane drove his L.N.E.R. $3\frac{1}{2}$-in. gauge $\frac{3}{4}$ in. scale "Bantam Cock," a lovable engine that must have run for some hundreds of hours during its life both on its own and other lines, and Mr. Eborn with his 1 in. scale "Halton Tank," 5-in. gauge, is a well-known performer on lines in at least two counties.

While paper restrictions prevent a full report and description of every one of the 250 exhibits, photographs of some outstanding modelling



An "M.E." cine projector for 9.5 mm. film made entirely by the exhibitor, J. Hellewell, including plating and enamelling. Patterns made jointly with another model maker



A $3\frac{1}{2}$-in. gauge working model of an early G.W.R. locomotive "Lorna Doone," by E. W. Fraser

seen at this exhibition are illustrated here.

The Clubs who supported the exhibition were :—

Vauxhall Motors Recreation Club, Model Engineering Section.

Luton and District Society of Model Engineers.

Aylesbury and District Society of Model Engineers.

Watford Model Engineering Society (who also loaned their track).

Geo. Kent Model Engineering Society.

Luton and District Model Aeronautical Society.

Percival Aircraft Model Engineering Society.

South Beds. Ship Model Society.

The S.M.E.E.

It is felt that this effort must surely go down on record as one of the fine examples of co-operation and comradeship that belong to model engineering, and to the wives and friends who helped to make the exhibition a success, we tender our thanks.

Examples of wood and ivory turning by G. C. Brandon of the Vauxhall Motors Recreation Club

Cylinders for "Maid" and "Minx"

by "L.B.S.C."

BEFORE going into details of the cylinders for the "Maid of Kent" and the "Minx," I might mention that correspondence continues to roll in, arguing the pros and cons of ferrous and non-ferrous cylinder castings, and extolling the virtues of piston rings against soft packing. I have already pointed out the disadvantages of using cast-iron cylinders in cases where the engine stands for a week or more without turning a wheel, and also what would happen to the cylinder-bores of bronze cylinders with ringed pistons, should the lubrication fail even for a very short time. There is one other point worth noting. A correspondent recently sent for inspection, a set of bronze piston rings. Although obviously they had been carefully machined, they "fitted where they touched," as the kiddies would say; from the marks on them, they had only been touching the cylinder-bores for about half the total circumference, at intermittent spots. Doubtless, with a little more wear, they might have shown rubbing marks over the whole of the circumference; but meanwhile, what would have been happening to the cylinder-bores? You can't have two rubbing surfaces operating without wear on both, and whilst the parts of the rings touching the cylinder-bores were wearing them away, there would be "nothing doing" where no contact was being made; consequently, by the time the hitherto unworn parts of the rings had come into contact with the cylinder-bores, same would have become polysided instead of being truly circular. In theory, the rings are supposed to turn around, and rub themselves in truly; but the rings don't care what they are *supposed* to do, and just please themselves. The precise moment they would select to start turning around, would be when both they and the cylinder-bores were well out of truth, and then, of course, steam would start to blow where "'oller met 'oller."

There is another disadvantage in gunmetal or bronze rings, and that is, that "red-hot" steam takes all the spring out of them, and you might as well use a bit of lead fuse wire. If you care to chance the rust and pitting when the engine stands for a long time unused, or if she will do plenty of work, use cast-iron cylinders, with cast-iron piston-rings and rustless steel slide-valves. For normal work, such as intermittent running on a railway, use bronze cylinders and soft packing.

How to Bore the Cylinders

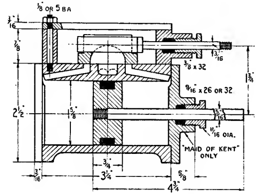
The cylinders illustrated here are of the usual simple kind, both cylinders being cast in one piece, and they resemble those I have already described for $2\frac{1}{2}$-in. and $3\frac{1}{2}$-in. gauge engines, except that the valves are driven by buckles as in full-size practice. The same measurements are suitable for both the "Maid of Kent" and the "Minx," the only difference being in the back covers. You will see that I have shown horizontally-disposed bosses, to accommodate a pair of side-by-side guide-bars, same as I used on "Jeanie Deans." The full-sized Ashford L1's have four bars per cylinder, like "Molly," but two bars with a slotted crosshead are much easier to fit up; and that is a consideration where time is limited, especially as it doesn't impair the efficiency of the engine in the slightest. On the "Maid of Kent," there is nothing between the frames on either side of the guide-bars, so the whole doings fits in all right; but on the "Minx," the leading hornblocks and axleboxes are directly behind the back cylinder covers, and the guide-bars as arranged for the passenger engine, wouldn't fit between them. I am therefore specifying a different arrangement for the goods engine, and will give a separate illustration.

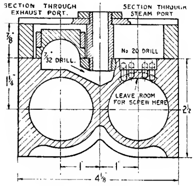
After dealing with $2\frac{1}{2}$-in. and $3\frac{1}{2}$-in. gauge cylinder castings, you'll find the 5-in. gauge casting a tidy chunk of metal to play about with as it measures $4\frac{1}{8}$ in. width, $2\frac{1}{2}$ in. height, and $3\frac{1}{4}$ in. length, when finished. Unless you have a good big lathe, it is a million dollars to a pinch of snuff that you won't be able to follow the instructions hitherto given, and mount the casting on an angle-plate attached to the faceplate. The casting could be mounted on a faceplate as small as 7 in. diameter, with packing to allow the boring-tool to go clean through. For this wheeze, you need one end at least faced off truly; otherwise, the bores would not be parallel. The easiest way of doing this in the lathe, would be to mount the casting on a mandrel driven through one of the core-holes, put the lot between centres, and face one end in the usual way. Only a roughing-cut would be necessary; and the mandrel could then be turned end-for-end, and the other end of the cylinder-block treated likewise.

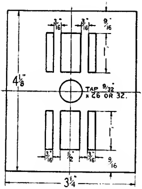
The next item would be to check off the core-holes, to see if their centres agree with the drawing. If so, well and good; if not, plug them with bits of wood, mark the true centres on the wood, and scribe circles on the cylinder end, to denote the true location of the bores. The casting is then set up on the faceplate in the same way that I described and illustrated for mounting the cylinders for a $2\frac{1}{2}$-in. gauge "Austere Ada" on the faceplate of an "Adept" or other baby lathe. To make certain your packing pieces are true, cut metal ones off a piece of brass or steel bar about $\frac{3}{8}$ in. square. Use three pieces ("three-point suspension"); as the old saw says, a three-legged stool always stands firm. There would be no need to bother about a holed clamp-plate, or a pipe-flange, as a bar across the casting, with bolts through it and the faceplate, would do the needful quite well, provided that it is set clear of the finished size of the bore. Set either the core-hole, or the scribed circle, as the case may be, to the needle of a scribing-block standing on the lathe bed, or to the point of a tool set crosswise in the rest, adjusting the casting on the faceplate so that the

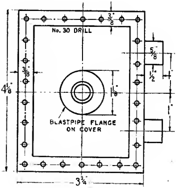
needle or point touches either the edge of the core-hole, or the scribed circle, through a complete revolution of the faceplate. Did I hear a beginner say "Won't the packing pieces fall out whilst adjusting?" You bet they won't, if you lay the faceplate on the bench when you kick off, put the packing pieces on it, then the cylinder casting (setting same "by eye" as true as possible), then the clamp-bar and bolts, and tighten the nuts just enough to hold the casting

and reverse direction of cut as soon as the tool clears the faceplate end. If operating by hand, feed very slowly indeed on the final cut. This will counteract any spring in the tool, and leave a nicely-finished bore. Don't forget, on non-self-act lathes, that the top-slide should previously be set to turn parallel, testing on a piece of rod held in the chuck. I have also described that in detail several times. When one bore is finished, take off the faceplate, reset the casting for bore









Cylinder sections, port-face and steam-chest for "Maid of Kent."

so that you cannot move it with your fingers, but not tight enough to resist a tap from a "bacon-rind" (hide-faced) or lead hammer. Screw the faceplate on the lathe, and you'll find it quite easy to tap the casting so that the bore runs truly, without any bits falling out; then tighten the clamp bolts, put a boring-tool in the slide-rest, and go ahead as described for previous cylinder-boring jobs.

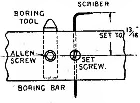
I don't suppose for one minute that there are any 1⅝-in. parallel reamers to be found in a home workshop; therefore, bore your casting to finished size. When within about 1/64 in. of the winning-post, regrind the tool and oilstone the edge; then carry on to the finished size, and finally take two or three traverses without shifting the cross-slide. If your lathe has a self-act, use it.

No. 2, and repeat operations, taking the same strict caution as before. After boring, mount the casting on a smooth stub-mandrel, and face off both ends to reduce the overall length to 3¼ in.

Boring with a Bar

Anybody whose lathe has a sliding saddle or boring-table, whether self-acting or not, can bore the cylinders with a bar between centres, so that the size of the lathe doesn't matter, within reason.. My friend Mr. Traylor (jovially known as "Bro. Teardrop") bored the cylinders of his 5-in. gauge 0-6-0 tank on a small cheap lathe purchased from Gamage's; the machine is quite accurate, substantial for its small size, and excellent value for the price paid. Clean up both ends of the casting as mentioned above,

and mark out; then fix up a boring-bar. This is merely a bit of stout round steel bar, centred at both ends; the bigger the diameter the better, as long as it will pass through the core-hole. Drill a ¼-in. cross-hole in the middle, and fit a ¼-in. grub-screw (Allen type if possible) cutting into the cross-hole. Make a very short boring-tool from a bit of ¼-in. round silver-steel; this must be of such a length that when the cutting end projects from the bar, just sufficient to take a



Boring bar

cut, the other end must not stand clear of the bar at all. Harden and temper to dark yellow, and fix it in the cross-hole.

Drill another small hole through the bar with No. 41 drill, and fit a set-screw to that also. In it, fix a miniature scribing-block needle, made from a bit of 3/32-in. steel wire, and set the bent point of this at such a distance from the bar, that it will describe a circle 1⅝ in. diameter if the bar is spun around. Now set up the casting on the saddle or boring-table; put the bar through one of the core-holes, supporting it by the lathe centres, and pack up the casting until, when the boring-bar is revolved by hand, the scriber needle follows exactly, the marked-out circle on the casting which denotes the location of the bore. The casting can then be clamped down to saddle or table, by crossbar, and bolts in the tee slots. Care must be taken to have the faced end of the casting dead square with the lathe-bed; and the easiest way of doing this, is to put the faceplate on the mandrel nose, and run the saddle up to it as close as possible. Then check the distance from faceplate to casting at both extremities, with a pair of inside calipers, or a slide-gauge.

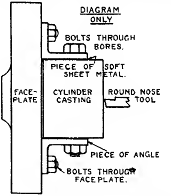
For the actual boring operation, first remove the scriber needle from the bar, and then set out the boring-tool sufficiently to let it take a cut. Don't run the lathe at too high a speed, and see that the carrier on the boring-bar is tightened properly, so that it can't slip. If the lathe has a self-act, use the lowest rate of feed; the old Drummond's had a feed of 110 per inch, which would do very well. If there is only a handle or hand-wheel on the end of the feed-screw, turn very slowly. As the casting travels along, the boring-tool in the bar should take out a clean cut. After one traverse, slack the set-screw, pull the tool a weeny bit farther out of the bar, and repeat operations, until the bore is right size. Then take two or three traverses as before, without shifting the cutter any more. After finishing one bore, don't release the clamp-bar holding the casting. Take out the boring-bar, move the cross-slide until the second core-hole lines up with lathe centres, replace bar with scriber needle attached, check up location of bore as detailed out above, then go ahead with the second boring operation. When that is through, the two bores should be quite parallel with each other, and of equal diameter right through.

The ends of the casting can be trued-up by mounting on a stub-mandrel in one of the bores. One end of this should be held in the three-jaw, and the tailstock centre brought up to support the outer end, as the overhang would be too great for the average small lathe. The stub-mandrel should not project beyond the outer end of the casting, otherwise you won't be able to take a cut, right across it. Reverse the casting end-for-end, naturally, to machine the other end.

Machining Port-face and Sides

As the casting can be held in a four-jaw chuck of 4-in. diameter, the sides and port-face should be easily machined in the lathe. Put a piece of soft sheet brass, copper or aluminium between the chuck jaws and the finished ends of the casting, to avoid marking them and spoiling the surface. Use a round-nose tool set crosswise in the rest. If the chuck is reasonably true, both sides should be parallel, and the port-face square to both.

Failing a chuck, the job could be mounted on the faceplate, but you couldn't use a clamp-bar and bolts, as the whole of the exposed surface has to be machined. If the lathe has a gap, and a big faceplate, it might be possible to hold it in a machine-vice attached to the faceplate; or you could use a dodge I found handy in the days when a lathe was my only machine tool. For machining off the port-face, the casting could be clamped between two bits of angle, with bolts passing through the bores, interposing a bit of soft sheet metal between angle and casting



How to machine port-face and sides

to prevent damage to the finished ends. Holes could be drilled through the free members of the angles, to suit the faceplate slots, and the whole bag of tricks bolted to the faceplate, the casting touching same to ensure the port-face being machined off parallel with it. The bits of angle could be used to hold the casting against the faceplate whilst facing off the sides, clamping them to the casting by a bolt through one bore only. The casting could not slip, as the opposite side to that being machined, would be bearing hard against the faceplate.

(Continued on page 230)

IN THE WORKSHOP

by "Duplex"

5—Formation of Flat Surfaces—Scraping

IN response to requests from readers, the subject of scraping is now being considered; and as this process enables the mechanic, using simple tools in the small workshop, to get results fully as accurate as those obtained in the large factory with its expensive equipment, it is a form of handwork well worth attention.

As scraping is, in the main, used to form flat surfaces or to bed such surfaces together, we may well begin by considering generally the production of flat surfaces in the workshop. Before surfaces are truly finished, they are, in the first place, usually machined flat, and the degree of flatness will depend on both the quality of the machine and the skill of the operator.

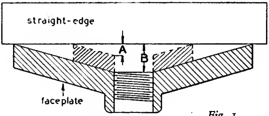


Fig. 1

The machines commonly used for this purpose are the lathe, the milling machine, the shaper and the planer. Shaping and planing machines are specially designed for this work, and if they are accurately made and of robust design, there should be no difficulty in producing good work, provided that proper cutting tools are used and precautions are taken to avoid distorting the material when fixing it to the machine table. The commercial milling machine will, of course, also give accurate results, but when milling in the lathe with multi-tooth cutters, the outcome is often disappointing owing to lack of rigidity in the mandrel and the machine slides. If there is any doubt on this score, fly-cutting should be adopted, for although it is a slower process for the removal of metal, accuracy is more readily attained, as has been explained in a previous article on this subject. Surface grinding when carried out commercially gives very accurate results, and very little hand scraping is required to finish the surface truly flat, but the necessary equipment is both elaborate and expensive.

In the small workshop with its limited equipment, flat surfaces are commonly formed by a turning operation in the lathe, and if light finishing cuts are taken, the results obtained will correspond with the inherent accuracy of the machine. In this connection, it should be noted that the cross-slide of the ordinary lathe is adjusted during manufacture to turn surfaces slightly concave, for the very good reason that two concave surfaces will mate together without rock and will form a good joint, whereas, if the surfaces were convex, this would not be so and the proper assembly of the parts would be rendered difficult.

This concave setting, which usually amounts to about a thousandth of an inch in four inches, is checked by the inspection staff, and if it is not found to be in accordance with the prescribed limits, the tool is put back for adjustment.

It will be evident that wear of the mandrel and machine slides may reduce the amount of concavity formed when the lathe is in operation, and it is necessary, therefore, to give an ample allowance in this respect to ensure that convex turning does not later develop. In the case of the precision lathe, on the other hand, where the hardened steel mandrel runs in hardened steel bushes and the slides are provided with very large and accurately fitted wearing surfaces, the possibility of the lathe setting altering with prolonged use is greatly reduced, and for this reason the cross-slide may be set to turn a concavity of even less than a quarter of a thousandth in four inches.

In view of what has been said, it will be manifest that it is not really practicable to attempt to true a defective faceplate by turning it when in position on the mandrel nose, for the faceplate should be truly flat in order that work bolted to it in any position may always lie exactly parallel with the lathe axis. This may be important when turning a crankshaft, as will be explained in a future article on this subject. If a trial cut is taken across the faceplate, the application of a straight-edge will reveal roughly the amount of concavity present, as shown diagrammatically in Fig. 1. To estimate this more exactly, insert a cigarette-paper or a feeler-gauge in the gap and move it about until it is just gripped; mark this position on the faceplate and divide the length between this mark and the edge of the faceplate into two, or more parts as a guide during the subsequent machining.

Assuming that the cigarette-paper is one thousandth of an inch thick, as is usually the case, and that it is gripped near the centre of the plate; then at the half distance the concavity will amount to half a thousandth only.

Take another light cut, and when the half-way mark is reached withdraw the tool and feed it forward to the previous setting less half a thousandth; then continue the cut to the centre. In this way, as shown diagrammatically in Fig. 1, the error of concavity is reduced to half its former value, and when it comes to scraping the faceplate truly flat much less work will be required. If

the error of concavity is considerable, more than one adjustment of the tool should be made during the facing operation.

If the slide index or its feed-screw cannot be relied on to make these fine settings, the dial test indicator should be clamped to the cross-slide with its contact point against the end of the top slide, all settings are then made by reference to the indicator.

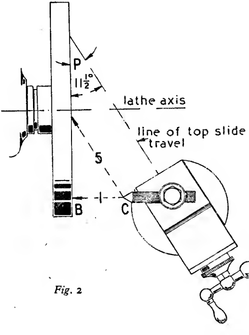


Fig. 2

An alternative method of accurately putting on a very small cut with the top slide is by setting the slide over, so that as it travels inwards the tool closes with the work by only a fraction of this amount, and any error when reading the slide index is thus correspondingly reduced.

Let us assume that we have decided to set the top slide so that the tool advances towards the work for one-fifth of the amount of the slide feed, and we want to know the angle to which we must set the graduated base.

This is a simple example of trigonometry and one which often occurs in the workshop. Reference to Fig. 2 will show the position set out diagrammatically, and we want to find the angle P to which the slide must be set so that as the tool is fed along the line CA for five units it will approach the work along the line CB by only one unit of distance. Now in trigonometry, dividing BC by CA gives what is termed the sine of the

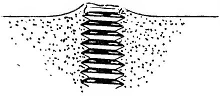


Fig. 3

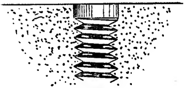


Fig. 4

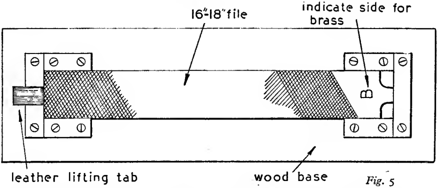


Fig. 5

angle P, and as we require that BC divided by CA should equal 1/5, we want to find out the value of the angle P when its sine equals 1/5 or 0.200. Reference to a table of sines, as may be found in publications such as Fowler's *Mechanics' Pocket Book*, will show that the sine of an angle of $11\frac{1}{2}$ deg. is equal to 0.19936, which is near enough for our purpose.

It will be found that when the top slide is set at right-angles to the lathe axis the reading on its scale is 90 deg.

Therefore, we must make the setting 90 less $11\frac{1}{2}$ deg., which is $78\frac{1}{2}$ deg.

By this means fine setting of the tool is greatly simplified; and whilst on this subject it may be pointed out that this method can also be used when turning cylindrical work, but in this case the slide is set over from the zero to the $11\frac{1}{2}$ deg. mark.

In the same way, other ratios of tool advance to index readings on the top slide feed-screw can be readily determined by reference to a sine table.

For those who prefer more direct methods, the slide can be set over by a process of trial and error as follows :—

If it is desired to put on a cut of one thousandth of an inch for ten thousandths travel of the top slide, a trial setting is made and the slide is fed forwards for 100 thousandths, as shown on its index, and meanwhile the deflection of the test indicator mounted in the tool-post is noted. The slide is then adjusted until the test indicator shows a total reading of 10 thousandths over the 100 thousandths range of the top slide travel.

The saddle should be clamped throughout the facing operation, and also the top slide after any adjustment of the tool has been made. These observations on making fine settings may seem unduly meticulous, but they are intended for those who seek accuracy by simple means and are prepared to go to some trouble to attain it.

The accuracy of a machined surface may be seriously upset unless due precautions are taken; for example, as shown in Fig. 3 drilled and tapped holes may cause considerable trouble. Here, it will be seen that the metal has been raised for some little distance round the hole, and it may be a tedious operation to restore the surface while maintaining its flatness. This upsetting of the surface can be avoided if, as shown in Fig. 4, the tapping-size hole is enlarged to the clearing-size for a depth equal to one and a half threads prior to the tapping operation; this is particularly important in the case of cast-iron parts, as this material is easily distorted in this way.

Filing Flat Surfaces

The preparation of flat surfaces by filing has not so far been mentioned, but where the surface is large and so affords good guidance for the file, this is not a difficult operation, provided that reasonable skill is exercised and that at no time is the file allowed to rock or tip on the work by a movement aptly described as "fiddling," but nowadays this term seems to have acquired a more sinister meaning. The action of draw-filing is helpful when finish filing narrow surfaces; that is to say the file is held across the body with one hand at either end and is then pushed and pulled along the work while maintained in a truly horizontal position.

The Filing Block

The chief difficulty arises when filing small parts which do little to prevent the file rocking, and in this case the filing block illustrated in Fig. 5 will enable a reasonably flat surface to be produced.

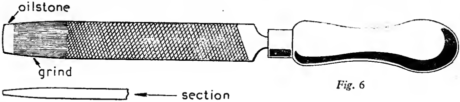


Fig. 6

A large file of moderately coarse cut is fitted to a wooden base and retained in place by stops. A leather tag is fitted at one end to enable the file to be lifted and turned over, for it is best to mark the two cutting faces and reserve them accordingly for filing brass and steel.

The base of the file can be marked with paint for this purpose, or if this surface is cleaned with emery-cloth, ordinary ink will give a lasting impression when letters are inscribed thereon. Before fitting to its base, the tang of the file is nicked on the grinding wheel and broken off in the vice. When in use the wooden base can, if desired, be clamped to the bench, and the work is held by the fingers of both hands and is pulled towards the operator against the cut of the file while pressure is applied; this pressure should be relieved on the backward stroke to avoid blunting the file. Pulling the work towards one is advised, as the muscular action involved is better controlled than in the reverse direction.

By increasing the pressure in any particular direction, the work can, if necessary, be thinned where required, but on no account must the work be allowed to rock on the surface of the file during the cutting stroke.

When the work has been prepared by turning, milling, shaping, planing or filing it is then ready for the final hand-scraping operation if a truly flat surface is required.

The Surface Plate

This provides a flat reference surface which is used to determine surface irregularities, and so enable other flat surfaces to be formed where required on the work with the aid of a hand-scraper. The process consists in applying the work to the surface plate after the latter has been lightly coated with a marking paste; this results in the high spots on the work being indicated by coloured areas, which are scraped away until, as the process is continued, uniform contact is established as shown by the continuity of the transferred marking. Surface plates are produced either by hand-scraping a machined plate, or the plate may be surface ground and then lapped flat.

The larger surface plates used in fitting-shops are generally made by the former method, and

the latter type are usually of smaller size for the use of tool and instrument makers. Hand-scraped plates can be readily made from a master plate, but to make a master plate, as was done in the case of the original true surface plate,

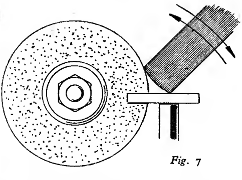


Fig. 7

three plates must be used: *A*, *B* and *C*; *A* is bedded to *B*, *B* to *C*, and *A* to *C*, and the work is continued until all the plates tried in pairs make accurate contact with one another. Surface plates can be purchased with either a planed or a hand-scraped surface finish.

Scrapers

Before dealing with the actual scraping process for forming flat surfaces or bedding surfaces together, the tools used for the operation will be considered, for if good work is to be expected these must be properly formed and sharpened.

The Flat Scraper depicted in Fig. 6 is perhaps best made from a discarded Swiss file, as these tools are made of very good material and but little grinding is required to remove the fine teeth. The length of the file should be sufficient to afford a good hold for the forward hand, in order to ensure proper guidance and control of the cutting edge; and in addition, a well-formed handle comfortable to the grip should be securely fitted.

The sides and end of the file tip are formed to the shape shown in the drawings in Figs. 6 and 7, by grinding on the periphery of a carborundum or other abrasive wheel, and it is important to use a coarse-grain wheel for the removal of the bulk of the metal to avoid overheating and softening of the cutting edge of the tool.

The work of grinding must not be hurried, and time should be allowed at frequent intervals for the tool to cool throughout its length, for the heat generated at the tip is conducted to and dispersed in the metal of the blade.

On no account should the blade be dipped in water to hasten cooling, for when grinding is resumed the evaporation of the water will cause metal cracks to form at the tip.

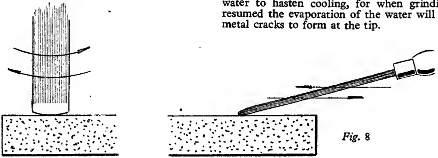


Fig. 8

The former are suitable for use as marking-out tables, but are not sufficiently accurate to serve as reference plates when scraping flat surfaces. The planed plates cost little more than half the price of those finished by hand-scraping, and if the loan of a good surface plate can be obtained, it will be a good exercise in hand work to scrape-in one of these machined plates to an accurate flat finish.

A sheet of plate-glass is an excellent substitute for a surface plate, but if it is of large size it must be supported on an even surface, otherwise distortion may be caused. Surface plates when not in use must be well protected against rusting and damage, and on no account should they ever be used as anvils or punching blocks.

Marking Compound

Marking-paste should give a clear transfer mark on the work, and, in addition, it should be easy to spread and should not dry like a paint.

Messrs. Stuart & Company, of Cleveden, make a compound which has been found to give excellent results over a wide range of work.

After completion of the preliminary grinding to shape, the surfaces should be finish-ground on a fine wheel to eliminate the coarse grinding marks. The next operation is to finish and sharpen the cutting edges on an oilstone.

The method of doing this is clearly represented in the drawings in Fig. 8, and the stoning must

Fig. 9

be continued until all grinding marks have been eliminated, otherwise conspicuous lines will be formed on the scraped work.

At this stage the tool should be tried on a piece of cast-iron or mild-steel, and if it does not bite into the metal and give a clean cut with but little applied pressure, the sharpening must be continued until this is effected.

A modified form of flat scraper is shown in

Fig. 9. This tool is used for scraping the V-slides of machines where the ordinary form of scraper cannot deal effectively with the overhanging surfaces. It is made in exactly the same way as the previous form, except that the sides of the file must be carefully ground away; or alternatively, the file may be forged to shape, but this will, of course, entail subsequent hardening and tempering.

The Triangular Scraper shown in Fig. 10 can be made from a triangular file. The sides

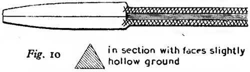


Fig. 10

of the file are ground against the periphery of the wheel until they meet at a sharp edge, and it will be noted that this will produce hollow-ground surfaces, thereby greatly lessening the amount of metal requiring removal on the oilstone during the final sharpening and subsequent resharpening operations. Another form of scraper which is really a variety of the foregoing, and is also used for scraping hollow surfaces such as bearing brasses, is shown in Fig. 11. Here, as will be seen, the shape is more complicated and in consequence these tools are usually acquired from the tool vendor; but, if desired, they can be forged to shape from file steel and afterwards hardened and tempered. In the form shown, the metal supporting the cutting edges is greatly reduced to facilitate sharpening on the oilstone.

Scraping

At the outset, the surface plate should be carefully cleaned to ensure that it is free from all old marking compound and other unwanted material; its surface is then lightly and evenly smeared with marking over an area corresponding with the size of the work. The marking can be spread with the finger tip, but as this is

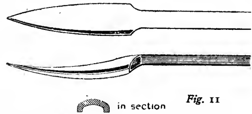


Fig. 11

rather a messy business it is better to use a piece of rag or soft leather, which will absorb the marking and will only need recharging at long intervals. The importance of using a non-drying marking compound will be manifest, for paint-like materials will dry-out both on the surface plate and in the applicator, thereby causing unnecessary trouble.

After the surface plate has been prepared in this way the work is applied to it, and at this stage it is most important to determine whether the work rocks on the plate; for if it does, this must be first corrected, otherwise a futile attempt may be made to scrape the work flat when first applied in one position and then in another.

Hold the work firmly pressed to the plate in *one* position and give it a short circular movement; this should reveal the situation of the points on which the work rocks.

If there is considerable rocking present, the high places may be reduced with a file, but if the rock is only slight the error can be corrected with the scraper.

It should be emphasised that it is always advisable when possible to use the scraper for this purpose, as it will remove only a small amount of metal in exactly the place required, whereas an injudicious stroke with a file by creating a low spot may lead to unnecessarily prolonged scraping to correct the error thus caused.

When the part has been bedded without rock, the transfer marks should be carefully examined and an estimate made, possibly with the aid of a straight-edge, as to where and how much metal must be removed to make the work truly flat.

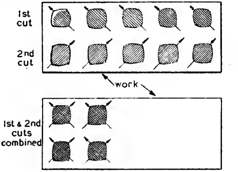


Fig. 12

As experience is gained, this matter will become greatly simplified, and a skilled mechanic can tell almost at a glance what is required. Begin by attacking the obvious high spots where the marking is heavy, and at the first passage of the scraper make the cuts in one direction diagonally across the work as shown in Fig. 12.

The correct angle at which to hold the scraper to give free cutting without digging into the work will soon be found with a little practice. Before applying the work again to the surface plate, spread the marking evenly and clean the work surface. Examine the work to see what effect the scraping has had in eliminating or widening the area of each high spot; this should give some idea of the height of the upstanding parts and the amount of work required to level them. At the second passage of the scraper, again make the cuts diagonally across the work, but this time at right-angles to the previous direction as shown in Fig. 12.

If this is not done and all cuts are made in one direction, the scraper will tend to dig into the scraped surface and the work will become ridged

As the scraping is continued in this manner, it will be found that the transfer marks form larger areas and become more evenly distributed

on the work surface; in time a final stage will be reached where good even contact is obtained which further scraping does little to improve.

If during the course of the work the scraper is found to require increased pressure to make it cut, or tends to skid over the surface, then resharpening as illustrated in the drawings must at once be carried out. When scraping hard cast-iron, or if hard spots in the material are encountered, resharpening will frequently be necessary.

If the scraped surface is to be open to the view, its appearance will be greatly enhanced by a finishing operation with the scraper. This consists in going over the whole surface of the work and making very light cuts on the two diagonal lines as before, but in this case an attempt should be made to make the scraper markings identical. With a little practice this will become almost automatic, and from the point of view of good appearance it matters little what the pattern is, so long as it is regular in form and spacing. Some mechanics like to form crescents, others rectangles, but the pattern formed will depend largely on the dexterity of the operator and the shape of the scraper's cutting edge. Let it not be thought that scraper marks on sliding surfaces are purely ornamental, for they are of value in retaining an oil film and maintaining the lubrication of the parts. It is largely for this reason that when two ground or highly-finished sliding surfaces are bedded together, one of them should always have a scraped finish, or be broken up as it is termed.

Turning now to the use of the triangular scraper; this is employed in either of the two forms illustrated for work such as bedding a crankshaft into its split bearings with the bearing caps bolted in place. In this case the crankshaft journals take the place of the surface plate.

The crankshaft bearing surfaces, or journals as they are called, are smeared with marking compound and the shaft is then put in place and rotated; the resulting transfer marks on the bearing brasses will then reveal the high spots.

The first part of the operation consists in bedding the crankshaft to the half brasses located in the crankcase, with the bearing caps removed; for were the latter bolted down at this stage the crankshaft might be distorted to conform to the untrue bearing surfaces, and faulty fitting would result. The scraping-in process here is exactly similar to that described in the previous instance.

When the half-brasses have been scraped-in, the bearing-caps are bolted down and scraped until good even contact has been obtained. During this process the caps may have to be filed down, or bearing shims removed, in order to maintain good bearing contact, as well as free running of the shaft.

To return to the subject of forming flat surfaces, it should be mentioned that where a highly finished flat surface is required, as in gauge making, a final lapping operation is usually employed, that is to say the work is rubbed on a flat surface charged with fine abrasive material.

Unfortunately, one truly flat surface cannot readily be formed from another in this manner, and the surface of the work is apt to assume a convex form. To counteract this tendency the lap surface should be very slightly convex, and in practice, good results can be obtained by using a sheet of plate-glass which has been distorted to this shape. The sheet of plate-glass is placed on a central felt or leather pad and its edges are supported on strips of less thickness; if weights or clamps are now applied to the edges, the sheet will assume a convex form with a slightly raised centre. This portion of the glass is then used as a lapping surface with a fine abrasive, and the work is rubbed to and fro, and with a circular motion until the appearance of the surface shows that contact has been everywhere established.

The flatness of this surface can be tested by reference to a toolmaker's surface plate with a lapped finish, or alternatively, it will be found that two accurately lapped parts will adhere firmly when wrung together.

"L.B.S.C."

(Continued from page 224)

Lucky owners of a milling-machine, planer, or shaper, would, of course, use that useful tool instead of the lathe to do the job. My own horizontal miller would make short work of the whole doings; the machine-vice on the table, opens wide enough to grip the casting, and the bottom of the slide is quite true with the table. All I would have to do, would be to open the jaws of the vice, drop in the casting, letting it rest on the slide, tighten up, put my widest slabbing-cutter on the arbor, set the self-act, and leave the job "to do itself."

A small bench miller would do the job (though not so quickly!) equally well, using an ordinary cutter, even if only about $\frac{3}{8}$ in. wide, by taking a number of overlapping cuts across the face and sides. The casting would also be held in the machine-vice, on a planer or shaper, and the surplus metal taken off by a round-nose tool in the clapper box, traversing either work or tool according to the machine. A port-face finished on a milling, planing or shaping machine will need a final true-up after the ports have been cut, as it will probably be covered with fine ridges.

A word to those who follow my notes for a little amusement as well as instruction. The primary object of them is to tell all and sundry how to build little steam locomotives that will do a real job of work, same as their big sisters; and I try to "put a little jam around the pills," to make it interesting. Well, the trouble is, that according to my correspondence, some good folk want more jam than pills, and would rather read about what young Curly got up to in his schooldays, or what he did on the railway, than follow a dissertation on making up a valve-gear or Sif-bronzing a boiler! I do my best to please all, and will try to raise a few more smiles soon.

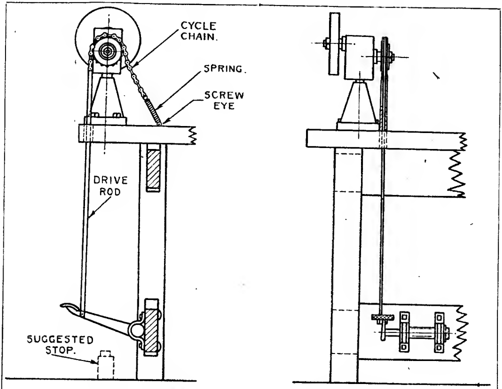
Treadle Drive for a Hand Grinder

by F. Emmerson

DRIVEN by the knowledge that my hand-operated bench grinder was very difficult to operate single-handed and not being able to afford the luxury of an electrically-operated appliance, I looked around for some means of operating by treadle action. Belts being out of the question, some sort of ratchet-drive seemed to be "just the job," and, eventually, I hit upon the scheme outlined here.

The drive shaft of my Millenium pedestal bench grinder happens to be squared, so, a square was formed inside a steel disc to fit the shaft, and the outside of this disc was filed to fit snugly inside a bottom-bracket cup from a bicycle (in my case this "disc" was a large mild-steel nut blank). I next brazed the disc inside the bottom-bracket cup.

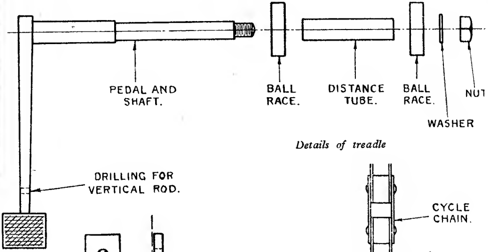
The above attachment was next fitted to the drive shaft, secured by a washer and nut. The washer, omitted in the exploded sketch, must be almost as large in diameter as the cycle bottom-bracket cup, so as to stop a nut, which may be of small size, from passing through the fairly large opening of cup. To allow for this washer, the thickness of the steel disc is less than the length of squared shank on drive shaft, as is made clear in the sketch. A cycle free-wheel was next screwed on to the cup, and locked by means of a bottom-bracket locking-ring. Over the free-wheel was placed a short length of cycle chain, of suitable size, secured to the bench at one end by means of a 3 in. by 20 s.w.g. tension spring, the other end of chain, say the front end, is connected to the drive-rod from the treadle (*see* drawing).



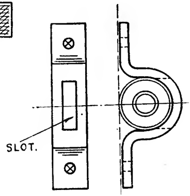
Side and front elevations of treadle attachment for hand grinder

The treadle in my case is an old motor-cycle footbrake pedal, which is attached to the cross-rail of the bench by two small ball-races, fitted and retained as shown in drawing. The ball-races are secured by means of suitable brackets, made up from 1-in. by ¼-in. steel bar, clearly explained in drawing.

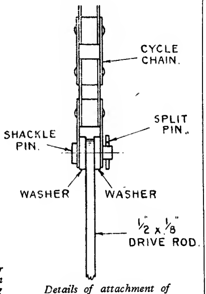
I have purposely refrained from giving dimensions, because many of the parts are oddments which may be impossible to duplicate. Then again, my grinder is, perhaps, an unusual type,



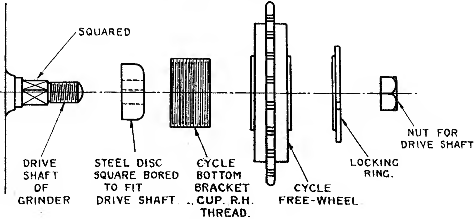
Details of treadle



Detail of bearing brackets.—Note how slot is slightly shorter than diameter of ball-race, thus forcing ball-race tightly on to the wood of bench cross-member; at the same time allowing portion of outer race to be held in slot, so preventing side play



Details of attachment of drive-rod to chain



Detail of ratchet-drive

even if only in shape, so that measurements would be superfluous.

Another point worth noting is, that the drive shaft of my grinder rotates the same way as the wheel. This is not often the case with bench grinders, so that to apply this drive to a machine with an opposite drive, would entail the following alterations :

1. The fitting of a locking-ring on the grinder side of the bottom-bracket cup.
2. Reversing of free-wheel before screwing on to the cup.
3. Attachment of spring to front end of chain.
4 Attachment of drive-rod to rear end of chain.
5. Arrangement of drive-rod at an angle to connect to same position on treadle arm, or construction of longer treadle arm, located farther back than mine is, to allow of setting drive-rod behind grinder and vertical.

NOTE. The length of chain will depend on the following :—

1. Thickness of bench—this may demand considerable length of drive-rod projection to allow of full travel of treadle.
2. Travel of drive-rod—shackle-pin may contact bench at fully-down position if chain is too long. (If hole through bench is large enough to clear shackle-pin and chain this will obviate some trouble.)
3. Extension of spring—travel of drive-rod and length of chain must be such as to allow adequate travel of treadle without extending spring sufficiently for it to contact teeth of the free-wheel. (Perhaps a stop can be arranged to limit downward movement of treadle.)
4. Return pull of spring—this should not be sufficient to pull drive-rod back on to the teeth of the free-wheel. (If hole in bench is large enough [see paragraph 2] then this will allow shorter drive-rod, and longer chain, so avoiding this trouble.)

Editor's Correspondence

Hot-Air Engines

DEAR SIR,—I was interested to read the article on the hot-air engine, by B. C. J. in THE MODEL ENGINEER, of December 18th, 1947, as I have often thought that this prime mover has possibilities, if some of the effort directed at perfecting the internal combustion engine could be applied to hot-air engine problems. There is a considerable latent demand for a small, compact trouble-free prime mover for powers up to about 7 h.p. which would be capable of providing some of the benefits of electricity in the many out-of-the-way places in the world which are never likely to have a public supply. It would seem that a hot-air engine could possibly satisfy the conditions better than the air-cooled petrol engine which at present holds the field for this class of work. The ideal engine for these small plants would be able to utilise any fuel, solid, liquid or gaseous, would require little or no water, would be silent in operation, would form a compact unit with its driven machine, i.e. generator, pump, etc., and would be capable of running more or less unattended with the minimum of skilled attention.

Incidentally, there are a number of hot-air engine-driven fans in use in this country. They are, I believe, of American origin and have a single-cylinder inverted engine which drives a four-bladed fan of about 24 in. diameter at about 150 r.p.m. Paraffin is the fuel used and they are very silent and quite effective.

Yours faithfully

Khartoum. R. R. MAY, A.M.I.Mech.E.

Triple Geared Lathes

DEAR SIR —I have followed, with some interest, the correspondence on this subject in your columns and I thought that a brief description of a similar lathe which is in daily use at our forge might be of interest to your readers.

The lathe in question is an 8-in. × 4-ft. bed, screw-cutting type and will take up to 30 in. in the gap. The bed is of the old-fashioned flat type, about 12 in. wide on the top face, and has double vees. The saddle is guided by these outer vees, while the tail-stock is aligned by a tenon-piece on its base, which fits between the shears of the bed. The cross and top slides are of massive construction, and have coarse threads of 3 and 5 t.p.i.. respectively.

The headstock is fitted with the normal type of back gear, the second shaft being on the eccentric principle and the lock being a sliding bolt on the face of the large mandrel gear.

The pinion which normally engages with the mandrel gear is constructed to slide to the left, out of engagement with its gear, and the third gear is carried on a short shaft running in a bush cast into the front of the headstock. This shaft slides to the right, and engages with the sliding pinion on the back gear shaft. On the outer end of this short shaft is a pinion which engages with an internally cast gear on the back of a special faceplate, giving an overall reduction of 44 : 1.

The lathe has been in our possession for about a year only, and I have not yet had occasion to use this very low ratio, but I imagine that it would prove very useful for any outsize job.

The chief use to which the machine is put at the moment is for jobs of the agricultural engineering class, which do not require such close limits as the usual run of work, but I have held half-thou. limits without difficulty, and have, with due care, managed even finer jobs.

The lathe was built by J. Broadbent, of Sowerby Bridge, and I would be very pleased to hear from readers who can give me any information regarding the age and history of these lathes.

Yours faithfully,

Tenterden. R. L. SWEATMAN.